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SPECIFICATION FOR CARBON CHROMIUM MOLYBDENUM STEEL FORGINGS FOR HIGH TEMPERATURE SERVICE

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3

March 1964

Indian Standard

SPECIFICATION FOR CARBON CHROMIUM MOLYBDENUM STEEL FORGINGS FOR HIGH TEMPERATURE SERVICE

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Indian Standard

SPECIFICATION FOR CARBON CHROMIUM MOLYBDENUM STEEL FORGINGS FOR HIGH TEMPERATURE SERVICE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 14 February 1964, after the draft finalized by the Steel Forgings Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard has been prepared at the request of the Boiler Construction Materials Subcommittee, EDC 40 : 1, of the Boilers Sectional Committee, EDC 40. The standard covers the requirements for carbon chromium molybdenum steel forgings for pressure vessel shells, pipe flanges, forged fittings and valves for high temperature service.

0.3 The Sectional Committee responsible for the preparation of this standard kept in view the manufacturing and trade practices followed in the country in this field. Furthermore, due consideration has also been given to the need for international co-ordination among standards being followed in various countries of the world. These considerations led the Sectional Committee to derive assistance from the following standards:

B.S. 1503:620 (1958) 1 PERCENT CHROMIUM ½ PERCENT MOLYBDENUM STEEL FORGINGS. British Standards Institution.

ASA B16.5-1961 STEEL PIPE FLANGES AND FITTINGS. American Society of Mechanical Engineers.

0.4 Wherever a reference to any Indian Standard appears in this specification, it shall be taken as a reference to the latest version of the standard.

0.5 Metric system has been adopted in India and all quantities and dimensions in this standard have been given in this system.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960 Rules for Rounding Off Numerical Values (*Revised*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

0.7 This standard is intended chiefly to cover the technical provisions relating to carbon chromium molybdenum steel forgings for high temperature service, and it does not include all the necessary provisions of a contract.

1. SCOPE

1.1 This standard covers the requirements of carbon chromium molybdenum steel forgings for use up to a maximum steam temperature of 565°C.

2. SUPPLY OF MATERIAL

2.1 General requirements relating to the supply of forgings shall conform to IS : 1387-1959 General Requirements for the Supply of Metals and Metal Products.

3. MANUFACTURE

3.1 The forgings shall be manufactured from fully killed steel produced by the open hearth or electric process. In case any other process is employed in the manufacture, prior approval of the purchaser should be obtained.

3.2 Sufficient discard shall be made from each ingot to secure freedom from piping, harmful segregation and other similar defects.

3.3 Unless specified otherwise, the material shall be made from ingots having at least twice the cross-sectional area of the material.

4. CHEMICAL COMPOSITION

4.1 The material, when analysed in accordance with IS : 228-1959 Methods of Chemical Analysis of Pig Iron, Cast Iron and Plain Carbon and Low Alloy Steels (*Revised*), shall conform to the requirements specified in Table I.

TABLE I CHEMICAL COMPOSITION

(*Clause* 4.1)

STEEL DESIGNATION*	CONSTITUENT	PERCENT
15 Cr 90 Mo 55	Carbon	0·10 to 0·20
	Silicon	0·10 to 0·35
	Manganese	0·40 to 0·70
	†Nickel	0·30 *Max*
	†Copper	0·40 *Max*
	Chromium	0·70 to 1·10
	Molybdenum	0·45 to 0·65
	Sulphur	0·050 *Max*
	Phosphorus	0·050 *Max*

**see* IS : 1762-1961 Code for Designation of Steel.

†Incidental elements (*see* **4.2**).

4.2 Incidental elements shall not be added deliberately except for the purpose of finishing the heat. Analyses for incidental elements will not normally be required unless reason exists to suspect their presence in excessive amounts; spectrographic analysis may be used for this purpose.

5. FORGINGS

5.1 The amount of hot-working shall be such as to ensure complete soundness and adequate uniformity of structure and mechanical properties.

5.1.1 Forgings shall be brought as nearly as practicable to the finished shape and size by hot-working, and shall, where practicable, be so worked as to cause metal flow in the direction most favourable for resisting the service stresses where these are known.

5.1.2 When specified in the order, the supplier shall submit for the approval of the purchaser, a sketch showing the shape of the rough forging before machining, and the supplier may also be required to show by sectioning and etching a representative forging that soundness and a satisfactory grain flow has been obtained.

6. FREEDOM FROM DEFECTS

6.1 The forgings shall be sound and free from harmful segregation, cracks and surface flaws. They shall be finished to the prescribed dimensions within limits as agreed upon between the supplier and the purchaser. Defects in forgings shall not be repaired without the previous permission of the purchaser.

7. HEAT TREATMENT

7.1 The forgings shall be normalized at a temperature between 920°C and 960°C and shall be given subcritical annealing treatment at a temperature between 620°C and 660°C.

7.1.1 If a forging is subsequently heated for any further forging, it shall be reheat-treated.

8. TESTING

8.1 The tests specified under **10** shall be made at the place of manufacture prior to despatch, but in the event of any forging proving defective during subsequent manufacturing operations, such forgings may be rejected, notwithstanding any previous certificate of satisfactory testing, provided that the forging has not been improperly treated after delivery.

9. SELECTION OF TEST SAMPLES

9.1 Selection and Number of Test Samples — All test samples shall be selected by the purchaser, and when so desired the tests shall be carried out in his presence.

9.1.1 The test samples shall not be separately heat-treated.

9.1.2 Sufficient material shall be left on each forging to enable test specimens to be taken from sample pieces cut lengthwise, unless otherwise specified and approved, from a portion of the forging having an average cross-sectional area except where a number of small forgings are required and the expense incurred by leaving test material on each one is excessive.

9.1.3 In the latter case the supplier, by agreement with the purchaser, shall supply at his own cost additional forgings as follows:

either

Not less than two forgings from each cast in each heat-treatment batch,

or

a) In the case of one hundred or more forgings, not less than two percent of the total order,

b) In the case of forgings less than one hundred in number, either one forging from each cast or one forging from each heat-treatment batch when the forgings in the batch are of similar analysis.

9.1.4 The purchaser may select for testing, from the total samples made from each cast, such forgings as he may consider necessary up to the extent of the quantity specified in **9.1.3**.

9.1.5 By agreement between the supplier and the purchaser, loose test pieces of equivalent ruling section may be submitted on the same basis as in **9.1.3**.

9.1.6 The test pieces shall be machined from the sample piece or from selected small forgings without forging down, and the sample shall not be detached from the forgings until the heat treatment of the forgings has been completed, except that in the case of hollow forgings closed at the ends, the test samples may be removed before closing and be subsequently heat-treated with the corresponding forgings.

10. PHYSICAL TESTS

10.1 Tensile Test — Tensile test shall be carried out in accordance with IS : 1608-1960 Method for Tensile Testing of Steel Products Other Than Sheet, Strip, Wire and Tube.

10.1.1 The tensile strength and minimum elongation, when tested in accordance with **10.1**, shall conform to the requirements given in Table II.

10.1.2 Should a tensile test piece break outside the middle half of its gauge length and the percentage elongation is less than that specified, the test may be discarded at the supplier's option and another test made from the same lot.

10.2 Bend Test — Bend test pieces shall be of rectangular section 25·0 mm wide and 20·0 mm thick, or proportionately smaller in case of smaller forgings. The corners may be slightly rounded to a radius not exceeding 1·6 mm by filing, grinding or machining, but the test pieces shall receive no other preparation.

10.2.1 Bend test shall be conducted in accordance with IS : 1599-1960 Method for Bend Test for Steel Products Other Than Sheet, Strip, Wire and Tube. The test piece, when cold, shall withstand without fracture, being bent through 180° either by pressure or by blows from a hammer till the internal diameter is not greater than that specified in Table II.

10.3 Izod Impact Test — Izod Impact test shall be carried out in accordance with IS : 1598-1960 Method for Izod Impact Test for Steel. The izod impact values shall be as given in Table II.

10.4 Additional Tests — When so required, additional tests other than those specified may be specified by the purchaser at the time of enquiry and order.

11. RE-TESTS

11.1 Should a test piece first selected by the purchaser (or supplier where testing and inspection are not carried out by the purchaser) not fulfil

TABLE II MECHANICAL PROPERTIES

(*Clauses* 10.1.1, 10.2.1 *and* 10.3)

STEEL DESIGNATION*	TENSILE STRENGTH kgf/mm^2	YIELD STRESS *Min* kgf/mm^2	ELONGATION PERCENT *Min* GAUGE LENGTH $5{\cdot}65\sqrt{S_0}$		DIAMETER OF BEND FOR BEND TEST		IZOD IMPACT VALUE *Min* kgf·m	
			Lengthwise (or Transverse) on Hollow Forgings	Transverse on Solid Forgings	Lengthwise (or Transverse) on Hollow Forgings	Transverse on Solid Forgings	Lengthwise (or Transverse) on Hollow Forgings	Transverse on Solid Forgings
15 Cr 90 Mo 55	50 to 64	30	20	16	$3T$†	$6T$†	5·53	3·46

*See IS : 1762-1961 Code for Designation of Steel.

†T = Thickness of the test piece.

the test requirements, one of the following alternative procedures may be adopted at the option of the purchaser:

a) *Large Forgings Individually Tested* — Two further test samples shall be selected from the same forging from which the defective sample was obtained and two further tests made.

Small Forgings from Which Representative Samples are Selected for Tests — Two further test samples shall be selected from the batch represented by the defective sample and two further tests made.

Should either of the additional test pieces fail to satisfy the test requirements, the forgings shall be deemed not to comply with this standard.

b) The material represented by the test piece shall be reheat-treated and re-tested.

If the re-tests do not give satisfactory results, the forgings represented by the test pieces which failed shall be deemed not to comply with this standard.

12. MARKING

12.1 Unless agreed to otherwise between the supplier and the purchaser, each forging shall be clearly marked with the following information:

a) Manufacturer's name or trade-mark,
b) Steel designation, and
c) Number and identification mark by which it can be traced to the cast of steel from which the forging was made.

12.1.1 Small forgings shall be bundled and the identification marks stamped on a tag attached to each bundle.

12.1.2 The product may also be marked with Standard mark.

12.1.3 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

12.2 Forgings shall be suitably painted with a colour in accordance with *IS : 2049-1963 Colour Code for Identification of Wrought Steels Products for General Engineering Purposes.

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002
Telephones: 323 0131, 323 3375, 323 9402
Fax : 91 11 3234062, 91 11 3239399, 91 11 3239382

Telegrams : Manaksanstha
(Common to all Offices)

Central Laboratory:	Telephone
Plot No. 20/9, Site IV, Sahibabad Industrial Area, SAHIBABAD 201010	8-77 00 32

Regional Offices:

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	323 76 17
*Eastern : 1/14 CIT Scheme VII M, V.I.P. Road, Maniktola, CALCUTTA 700054	337 86 62
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Institution of Engineers (India) Building, 1332 Shivaji Nagar, PUNE 411005	32 36 35

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*Sales Office is at 5 Chowringhee Approach, P. O. Princep Street, CALCUTTA 700072	27 10 85
†Sales Office is at Novelty Chambers, Grant Road, MUMBAI 400007	309 65 28
‡Sales Office is at 'F' Block, Unity Building, Narashimaraja Square, BANGALORE 560002	222 39 71

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